CLAIMS

What is claimed are:

5   1.   A method of programming a multi-level flash memory using a sensing circuit, which includes a comparator, a reference current supply unit, a sense amplifier driving determining circuit and a register array, comprising:

a data storing step of storing data, at a register, corresponding to a level to be programmed;

10   a second level program step of after a first program voltage is applied to word lines, turning off said sensing circuit to maintain the threshold voltage at a first level voltage if the data stored at said register is a first memory cell being a first data, and performing a program to raise the threshold voltage to a second level if the data stored at said register is the remaining memory cells

15   being not the first data;

a third level program step of after a second program voltage is applied to said word lines, turning off said sensing circuit to maintain the threshold voltage if the data stored at said register is the first or second memory cell being the first or second data, and performing a program to raise the threshold

20   voltage to a third level if the data stored at said register is the remaining memory cells being not the first or second data; and

a fourth level program step of after a third program voltage is applied to said word lines, turning off said sensing circuit to maintain the threshold voltage if the data stored at said register is the first, second or third memory

cell being the first, second or third data, and performing a program to raise the threshold voltage to a fourth level if the data stored at said register is the remaining memory cells being not the first, second or third data.

5   2.   The method of programming a multi-level flash memory according to claim 1, wherein said first data is "11", said second data is"10", said third data is "01" and said fourth data is "00".

3.   The method of programming a multi-level flash memory 10   according to claim 1, wherein said register has so much as the number of bits that can represent all the numbers of levels by which said memory cell can be programmed, so that data on the level to be programmed is stored.

4.   The method of programming a multi-level flash memory 15   according to claim 1, wherein said sensing circuit is turned on/off by said sense amplifier driving determining circuit depending on said first ~ fourth data stored at said register.

5.   The method of programming a multi-level flash memory 20   according to claim 1, wherein the program of said memory is an automatic verification program method, wherein an operation of the automatic verification program method is stopped at the time when the threshold voltage of said memory cell becomes higher than the reference cell of said reference current supply unit by comparing the reference current generated in said

reference current supply unit with a drain current of said memory cell using said comparator.

6.   The method of programming a multi-level flash memory according to claim 1, wherein first ~ third program voltages applied to said word lines are determined to be a medium voltage of each of the threshold voltages and are sequentially applied from a low voltage.

7.   A method of reading a multi-level flash memory using a sensing circuit, which includes a comparator, a voltage regulating block, a reference current supply unit, a sense amplifier driving determining circuit, a register array and a counter, comprising:

a first initialization step of setting to store a fourth data at all the registers, apply a first read voltage to word lines and output a first data to said counter;

a first read step of sequentially comparing a first reference current of said reference current supply unit with a drain current of the memory cells in said comparator, and then storing the first data at a corresponding register to define a first memory cell, if said threshold voltage is lower than the reference cell, and maintaining the fourth data stored at the register to complete the read operation of said first memory cell, if said threshold voltage is lower than the reference cell;

a second initialization step of setting to apply a second read voltage said word lines and to allow said counter to output a second data;

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a second read step of sequentially comparing a second reference current of said reference current supply unit with a drain current of the memory cells in said comparator only when said first memory cell is not, and then storing the second data at a corresponding register to define a second memory cell, if said threshold voltage is lower than the reference cell, and maintaining the fourth data stored at the register to complete the read operation of said second memory cell, if said threshold voltage is lower than the reference cell;

a third initialization step of setting to apply a third read voltage said word lines and to allow said counter to output a third data; and

a third read step of sequentially comparing a third reference current of said reference current supply unit with a drain current of the memory cells in said comparator only when said first or second memory cell is not, and then storing the third data at a corresponding register to define a third memory cell, if said threshold voltage is lower than the reference cell, and maintaining the fourth data stored at the register to complete the read operation of said third and fourth memory cells, if said threshold voltage is lower than the reference cell.

8.   The method of programming a multi-level flash memory according to claim 7, wherein said register has so much as the number of bits that can represent all the numbers of levels by which said memory cell is programmed, thus allowing more than 2 bits to be stored in case that data on the multi-bit flash memory cell is more than 2 bits.

9.   The method of programming a multi-level flash memory according to claim 7, wherein said sense amplifier driving determining circuit determines whether said sensing circuit has to be driven depending on the data stored at said register.

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10.   The method of programming a multi-level flash memory according to claim 7, wherein first ~ third voltages applied to said word lines are sequentially applied from a low voltage and each correspond to a medium voltage of the threshold voltage levels.

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11.   The method of programming a multi-level flash memory according to claim 7, wherein said first data is "11", said second data is "10", said third data is "01" and said fourth data is "00".

15   12.   The method of programming a multi-level flash memory according to claim 7, wherein said third read step detects only data of upper bits among data stored at said register and then determines them to be first or second memory cell if the data of upper bits is 1 (one) to be remaining cells if the data of upper bits is 0 (zero).

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13.   The method of programming a multi-level flash memory according to claim 7, wherein said sensing circuit is turned on/off by said sense amplifier driving determining circuit depending on said first ~ fourth data stored at said register.

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